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New evidence regarding the effects of contract farming on agricultural labor use

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Abstract

Contractual agreements between smallholder farmers and agribusiness companies have gained in importance in many developing countries. While productivity and income effects of contracting in the small farm sector were analyzed in many previous studies, labor market and employment effects are not yet well understood. This is an important research gap, especially against the background of continued population growth and structural transformation. Here, we investigate the effects of two types of contractual agreements between large international processing companies and smallholder farmers on agricultural labor use, household labor allocation, and hired labor demand in Ghana's palm oil sector. We use cross-sectional survey data and a willingness-to-pay approach to control for unobserved heterogeneity between farmers with and without contracts. We find that agricultural labor intensity is substantially reduced through the contracts, because contracting in Ghana is associated with the adoption of labor-saving procedures and technologies. Simple marketing contracts lead to reallocation of the saved household labor to off-farm employment, whereas resource-providing contracts lead to a stronger reallocation of labor within the farming enterprise. Household labor is more affected by labor savings than hired labor.

KEYWORDS
agricultural labor use, child labor, contract farming, gender, oil palm, rural employment

JEL CLASSIFICATION
J23, J43, O13, Q12

1 | INTRODUCTION

Contract farming has gained in importance in many developing countries, with agribusiness companies contracting small- and medium-scale farmers (Bellemare, 2018; Meemken & Bellemare, 2020; Otsuka, Nakano, & Takahashi, 2016; Ton, Vellema, Desiere, Weituschat, & D'Haese, 2018). Contract farming has positively contributed to income gains in the small farm sector and to broader agricultural development in many situations (Otsuka et al., 2016). However, the effects of contract farming on agricultural labor markets and employment are not yet sufficiently understood. Depending on the situation, contract farming can lead to higher farm labor demand and more labor-intensive agricultural production, or it can also contribute to on-farm labor savings, and

thus promote structural transformation with labor shifts from agriculture to other sectors. Here, we investigate the effects of contracts between large processing companies and smallholder farmers on agricultural labor use, including household labor and hired labor, in Ghana's palm oil sector. This is an interesting empirical example, because international palm oil companies are increasingly investing in Africa, so that the search for socially-inclusive business models is important from a rural development policy perspective (Byerlee, Falcon, & Naylor, 2017; Qaim, Sibhatu, Siregar, & Grass, 2020).

Many studies analyzed the effects of contracts on agricultural productivity and income in the small-farm sector (e.g., Ashraf, Giné, & Karlan, 2009; Barrett et al., 2012; Khan, Nakano, & Kurosaki, 2019; Mishra, Kumar, Joshi, & D'Souza, 2016; Ragasa, Lambrecht, & Kufoalor, 2018; Rao, Brümmer, & Qaim, 2012; Ruml & Qaim, 2020). Possible effects of contracts on agricultural labor use received much less attention in the empirical literature. This is surprising, because agricultural labor use, household labor allocation, and hired labor demand are all important aspects of household welfare, rural development, and broader structural transformation.

The few available studies that analyzed labor market effects suggest that contracting leads to additional labor use in farm production, harvesting, and postharvest handling (Benali, Brümmer, & Afari-Sefa, 2018; Meemken & Bellemare, 2020; Neven, Odera, Reardon, & Wang, 2009; Rao & Qaim, 2013). However, we argue that these results cannot be generalized, because contracting can also involve the adoption of labor-saving technologies and procedures. Labor-reducing effects through contracts were not shown previously in a small-farm context. Here, we show that they exist in Ghana's palm oil sector.

In particular, using data from a survey of farm households, we investigate the effects of two types of contracts—namely, marketing and resource-providing contracts—on labor use in oil palm production. While farmers without a contract do some of the postharvest handling themselves, farmers with a contract sell the oil palm fruit bunches to the buying company immediately after harvest. Some of the contracted farmers also use labor-saving chemical inputs, such as herbicides, thus further reducing labor intensity. We quantify the effects of contracting on total labor use per unit of land and investigate the resulting implications for household labor allocation and hired labor demand. In addition, we differentiate between male, female, child, and youth labor. Differentiation is useful to better understand possible broader social implications. Endogeneity issues in the evaluation of effects are addressed through including farmers' willingness-to-pay (WTP) for certain contract features as an additional explanatory variable in the regressions, which is a useful approach to control for possible unobserved heterogeneity (Bellemare & Novak, 2017).

Contract farming in Ghana's palm oil sector is not a peculiar case. Many smallholders in Africa have traditionally produced palm oil for home consumption and local markets. However, demand for palm oil from domestic and international markets is growing, so that modern supply chains with new actors and smallholder contract schemes are increasingly emerging in Africa (Byerlee et al., 2017). Similar trends are also observed in other crops traditionally grown by smallholders. Against this background, better understanding the labor market implications of contract farming is particularly important.

The rest of this article is structured as follows. The next section presents further details of trends in Africa's palm oil sector, including a description of traditional and modern supply chains. Section 3 describes the data collection and the statistical methods, Section 4 presents and discusses the empirical results, while Section 5 concludes.

2 | BACKGROUND

Over the last few decades, international demand for palm oil increased tremendously. This led to a substantial rise in the area under oil palm cultivation, particularly in South East Asia (Byerlee et al., 2017). In West Africa, where oil palm actually originates, production levels stagnated in recent decades (Huddleston & Tonts, 2007). This situation is now gradually changing. In South East Asia, the land for future oil palm expansion is limited and production growth increasingly conflicts with tropical rainforest conservation objectives (Qaim et al., 2020). Hence, to meet the further rising international demand, palm oil companies have also started to invest in Africa. In Ghana, the area under oil palm increased from 160,000 hectares in the year 2000 to over 370,000 hectares in 2018. During the same period, national production volumes rose from 1 million tons to 2.6 million tons of fresh fruit bunches (FAO, 2019). Similar trends are also observed in other West African countries. Oil palm is already one of the most important cash crops produced in West Africa and substantial further growth is expected in the future (Byerlee et al., 2017; Rhebergen et al., 2016).

The transformation of oil palm from a local semisubsistence crop, which it was for centuries in Africa, to a major cash crop is associated with supply chain modernization and the entry of large processing companies. In Ghana, the location of company-owned palm oil plantations and processing facilities is primarily determined by land concessions that the companies obtain from the Ghanaian government. Some of the palm oil that the companies process is produced on these company-owned plantations. In

TABLE 1 Production and marketing characteristics in oil palm with and without contract

	Traditional, without contract	Marketing contract	Resource-providing contract
Buyer	Local customers, small processing mills	Processing company	Processing company
Product sold	Oil palm fruits, palm oil	Oil palm fruit bunches	Oil palm fruit bunches
Production assistance	None	None	Inputs, technologies, technical support on credit
Labor operations	Plot maintenance (m)	Plot maintenance (m)	Plot maintenance (m)
	Input application (m)	Input application (m)	Input application (m)
	Harvesting (piecemeal) (m, f)	Harvesting (at once) (m, f)	Harvesting (at once) (m, f)
	Picking of fruits (m, f, c, y)		
	Processing (m, f)		
	Marketing (m, f)		

Notes: (m) indicates that the operation is typically performed by adult males. (f) indicates that the operation is typically performed by adult females. (c) and (y) indicate that children and youths are also involved occasionally.

addition, the companies procure oil palm fruit bunches from surrounding smallholder farmers through contractual agreements. Smallholder farmers continue to be the main producers of oil palm in West Africa. In Ghana, smallholder production accounts for 75% of total palm oil supply (Byerlee et al., 2017). Smallholder palm oil producers are also an important employer in Ghana, providing jobs for several hundred-thousand farm workers (Manley & Leynseele, 2019; Ministry of Food and Agriculture, 2011).

To this point, five large national and international palm oil processing companies procure their supply from contracted smallholders in Ghana, but the sector is evolving. Many smallholders still produce palm oil for traditional local markets without any contracts, whereas new companies and contract schemes are emerging, largely depending on where the government provides additional land concessions. The production and marketing conditions between traditional supply chains without contracts and modern supply chains with contracts differ remarkably. In traditional supply chains, farmers have no secure sales market. They harvest the fruit bunches and then pick the individual fruits out of the bunches, in order to sell to local customers or home process to palm oil. Picking, processing, and finding a buyer are time-intensive operations. As the quantities traded in local markets are small and the fruits are perishable, harvesting in traditional supply chains typically takes place in a piecemeal fashion.

In contrast, farmers in modern supply chains with a contract have a secure sales market where prices are fixed annually. Contracted farmers harvest the bunches, but instead of picking the individual fruits out of the bunches and processing themselves, they sell the bunches to the buying companies at the farm gate. In other words, the labor-intensive postharvest operations are no longer carried out on the farm. The companies have large mechanized mills where the fruit bunches are processed. Compared to the home processing of palm oil, and the small local mills that continue to use manual techniques (Byerlee et al., 2017), larger mills produce at higher processing capacities of 20–30 tons per hour. This means that farmers in modern supply chains with a company contract can harvest and sell larger quantities of fruit bunches at once.

In Ghana, two types of contracts exist in the palm oil sector, namely, marketing and resource-providing contracts, as shown in Table 1. For both types of contracts, the harvest and sales conditions are as described above. However, the contracts differ in terms of the additional assistance provided for production inputs and technologies. While farmers with a marketing contract do not receive production assistance, farmers with a resource-providing contract can obtain planting material, chemical inputs, other production tools, and technical support on credit from the contracting company. This credit is paid back through a share of the harvest and the commitment to sell to the contracting company. Thus, in addition to providing a secure sales market, the resource-providing contract addresses farmers' financial constraints through interlinking output, input, and credit markets. Farmers producing under marketing contracts and farmers without contracts are not involved in such market interlinkages.

The described differences between traditional and modern supply chains lead to the expectation that contract farming has a labor-saving effect on oil palm production at the smallholder level. Whether this is really observed empirically is analyzed below. The expected reduction in agricultural labor intensity raises additional questions. Farmers could either use the labor saved per unit of oil palm land to expand the area cultivated, thus keeping the total agricultural labor use constant, or they could reallocate the labor saved to off-farm activities. Obviously,

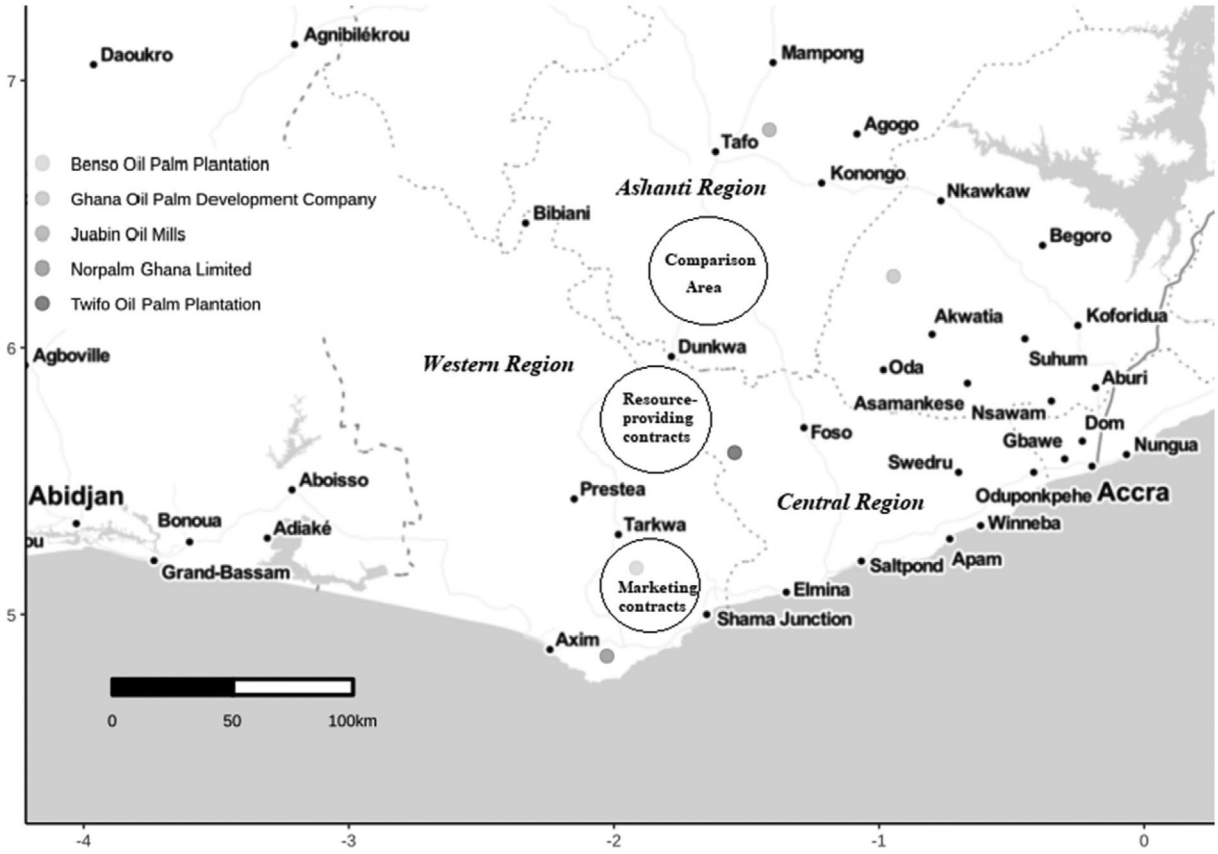

FIGURE 1 Map of study area in Ghana
Source: Authors' own presentation using tools provided in Kahle and Wickham (2013).

expansion of the area cultivated would require access to additional land and capital. In our study region in Ghana, land is not the major limiting factor. In fact, most farmers have more land than they actually cultivate. However, farmers typically face financial constraints to expand the oil palm area, as new oil palm plantations are costly to establish and only start bearing fruits after several years.

Against this background, it is likely that marketing contracts and resource-providing contracts lead to different types of labor reallocation. As mentioned, farmers with resource-providing contracts have access to credits for the establishment and maintenance of oil palm plantations, whereas farmers with simple marketing contracts do not. Indeed, another recent study using the same survey data showed that resource-providing contracts contribute to higher smallholder production investments and larger areas cultivated with oil palm, whereas simple marketing contracts do not have such effects (Ruml & Qaim, 2020). Effects on labor use and labor reallocation were not analyzed previously but will be evaluated here.

In particular, we investigate the effects of both types of contracts on (a) total agricultural labor use per acre of oil palm, (b) household labor use, (c) hired labor use, and (d) the time worked in off-farm employment. In addition, we disaggregate the labor use effects by gender, separating between male and female adults, and also analyze possible implications for child and youth labor. Table 1 suggests that both types of contracts lead to a reduction or omission of farm operations that often also involve women, children, and youths, so that examining effects by gender and age can provide useful additional insights.

3 | MATERIALS AND METHODS

3.1 | Sampling strategy and farm household survey

We conducted a survey of oil palm-producing farm households in Ghana between April and July 2018. When we sampled regions and households for the survey, there were a total of five large palm oil processing companies with company plantations and smallholder contract schemes (Figure 1). All five companies were located in the Southern parts of Ghana. Out of the five companies, we

purposively selected two that were located in neighboring regions quite close to each other, namely, Benso Oil Palm Plantation owned by Wilmar International in the Western Region and Twifo Oil Palm Plantation owned by Unilever in the Central Region. Benso has simple marketing contracts with farmers and started the contract scheme in the Western Region already in the 1990s. In contrast, Twifo uses resource-providing contracts and started to work with smallholders in the Central Region in 2008.

From both company schemes, contracted oil palm farmers were selected randomly based on complete lists of villages and farmers involved. Both companies stated that they offer the contracts to all oil palm farmers in the selected contract villages, provided that farmers agree to the contract conditions. This was also confirmed in focus group discussions, which we carried out in nonsampled villages prior to the actual survey.[1] In contract villages, most oil palm-producing farm households were contracted, and the few that were not sometimes still sold parts of their harvest to the company through informal arrangements with their neighbors.

Given that most farmers in the contract villages self-selected into a contract, we could not select comparison farmers without contract in the same villages without the risk of serious selection bias. Nor could we select comparison farmers in neighboring or nearby noncontract villages because these villages had not been selected by the companies for their contract schemes, probably due to different village or farmer characteristics. Our alternative was to select comparison villages and farmers in a different region located outside of the current contract area but otherwise sufficiently similar to the contract villages and farmers. This was possible because—as discussed above—Ghana's palm oil sector is evolving, and new company plantations and contract schemes are being planned and implemented.[2]

With the help of the Ministry of Food and Agriculture (MoFA), we identified a suitable comparison area in the Ashanti Region also in the southern part of Ghana, where the conditions are very similar, no contracting existed at the time of the survey, but a new contract scheme was about to start.[3] MoFA provided us with a list of villages in the Ashanti Region that had already been selected for the upcoming contract scheme. From this list, we randomly sampled villages and oil palm-producing farm households. The focus group discussions confirmed that farmers in these comparison villages were not aware of the upcoming contract scheme at the time of the survey, which was advantageous for us to collect comparable data from oil palm farmers in traditional supply chains without company contracts.

Our strategy to sample farmers with and without contracts in different (neighboring) regions (Figure 1) has pros and cons. On the pro side, it reduces or avoids selection issues within each region. On the contra side, there is perfect correlation between contract schemes and regions, so if the regions differ systematically, it would be difficult to know whether differences in the outcomes are due to differences in contracts or regional characteristics. We tried to minimize the possibility of systematic regional differences. All three regions—Western, Central, and Ashanti—are located in Ghana's green belt, which is classified as suitable for oil palm cultivation (Rhebergen et al., 2016). The three regions have very similar rainfall and temperature conditions (Table A1 in the online Appendix). Nor are there systematic regional differences in terms of soil quality and irrigation (Ruml & Qaim, 2020).

In addition to agroecological factors, we also compared the three regions in terms of various economic and social indicators, such as mean income levels, human development, and employment rates, which could possibly influence the labor market effects of contract farming. For all these indicators, we do not observe systematic regional differences (Table A1). This is also in line with our microlevel observations and the focus group discussions in all three regions. Of course, we cannot rule out completely that certain unobserved regional differences exist, so that some caution is warranted. We explain below how we try to control for observed and unobserved heterogeneity in our regression models.

In total, we randomly selected 463 oil palm-producing farm households from 31 villages in the three regions: 193 from the Western Region with a marketing contract, 164

[1] Focus group discussions were carried out separately with village officials (village chiefs, assembly men, lead farmers, and elder councils) and farmers. Village officials were asked about their perception of the contract farming scheme and the opportunities and challenges faced with the contracts, whereas farmers were asked about their production methods, access to land, labor, and inputs, and personal experiences with the contract scheme. The discussions were informal and often lasted for several hours of debate in local languages with English translation by a local interpreter. In total, eight focus group discussions were held: four in villages with resource-providing contracts, two in villages with marketing contracts, and two in villages without any contracts.

[2] As mentioned above, the regions and locations where company plantations are established cannot be freely chosen by the companies but are determined by where the government provides land concessions. Many of the recent concessions to palm oil companies were provided in the southern parts of Ghana, where our study is also located. Around the concession land for the company plantations, companies can select villages where they want to contract smallholder farmers. Villages are typically chosen based on distance, infrastructure conditions, and the number of oil palm-cultivating households.

[3] In other parts of the Ashanti Region, contract schemes of palm oil companies already existed at the time of the survey (Figure 1).

from the Central Region with a resource-providing contract, and 106 from the Ashanti Region without any contract. For the structured survey, personal interviews were carried out with the head of each of the sampled households in the local language, using a questionnaire developed for this purpose and programmed into tablet computers. The questionnaire captured information on the household structure, all income sources, the time spent by household members in various economic activities, and other socioeconomic details. Input–output details for oil palm production were captured at the plot level for all plots managed by the sample household. We use complete data for 524 oil palm plots, after excluding those that did not yet bear any fruits. In addition to the household interviews, we also conducted shorter structured interviews with the chief in each of the villages, capturing information on village-level characteristics.

3.2 | Regression models

In a first step, we estimate the effects of contract farming on labor use in oil palm farming with a regression model of the following type:

$$Y_{ihj} = \beta_0 + \beta_1 MC_{ihj} + \beta_2 RPC_{ihj} + \beta_3 X_{ihj} + u_{ihj}, \quad (1)$$

where Y_{ihj} is total labor use per acre of oil palm on plot i, in household h, and village j. MC represents the marketing contract and RPC the resource-providing contract; these are dummy variables taking a value of 1 if the household and plot are part of the respective contract scheme and 0 otherwise.[4] Thus, β_1 measures the effect of the marketing contract and β_2 the effect of the resource-providing contract. A negative and statistically significant coefficient would indicate that the respective contract reduces total labor use per acre of oil palm. We also control for other factors that may influence labor use in oil palm farming through the vector X_{ihj}, which includes plot, household, and village characteristics. u_{ihj} is a random error term that we cluster at the village level.

In a second step, we estimate disaggregated models using household labor and hired labor per acre of oil palm as separate dependent variables. As there are some farmers who do not use both types of labor, the dependent variables in these models include zero observations leading to corner solutions. This is accounted for by modeling two decisions for each type of labor as follows:

$$D_{ihj} = \propto_1 MC_{ihj} + \propto_2 RPC_{ihj} + \propto_3 X_{ihj} + \mu_{ihj} \; \mu_{ihj} \sim N(0,1), \quad (2)$$

$$Q_{ihj} = \gamma_1 MC_{ihj} + \gamma_2 RPC_{ihj} + \gamma_3 X_{ihj} + \varepsilon_{ihj} \; \varepsilon_{ihj} \sim N\left(0,\sigma^2\right), \quad (3)$$

where Equation (2) models the binary decision whether or not to use household (hired) labor on oil palm plot i, and Equation (3) models the decision of how much household (hired) labor to use on this plot, conditional on the first decision being positive. Hence, D_{ihj} is a dummy and Q_{ihj} a continuous variable. The other variables are defined as above. We estimate Equations (2) and (3) separately for household labor and family labor.

In a third step, we test whether contract farming leads to reallocation of household labor from farm to off-farm activities. This is tested with the following equations, which are estimated at the household level:

$$V_{hj} = \pi_1 MC_{hj} + \pi_2 RPC_{hj} + \pi_3 X_{hj} + \tau_{hj} \; \tau_{hj} \sim N(0,1), \quad (4)$$

$$W_{hj} = \varphi_1 MC_{hj} + \varphi_2 RPC_{hj} + \varphi_3 X_{hj} + \delta_{hj} \; \delta_{hj} \sim N\left(0,\sigma^2\right), \quad (5)$$

where V_{hj} is a dummy variable taking a value of 1 if at least one member of household h works in off-farm employment, and 0 otherwise, whereas W_{hj} is a continuous variable measuring the number of labor days worked in off-farm employment by all household members. Household labor is reallocated to off-farm activities if the coefficients π_1, π_2 and/or φ_1, φ_2 are positive and statistically significant. As discussed above, differences in labor reallocation effects between marketing and resource-providing contracts can be expected.

Moreover, we examine whether the effects are different for male and female household and hired laborers. This is tested by running the models in Equations (2)–(5) separately for male and female labor and comparing the coefficients. Finally, we investigate the effects on child and youth labor participation in the production of oil palm by reestimating the models in Equations (2) and (3) with child and youth labor as dependent variables.

We use double-hurdle specifications to estimate the models in Equations (2)–(3) and (4)–(5). The double-hurdle specification is suitable to estimate corner solution models with a binary first-stage decision and a continuous variable in the second stage. As such, it estimates two interlinked choices: the decision to employ the

[4] *MC* and *RPC* are possibly endogenous, which could lead to biased estimates. We discuss endogeneity issues and how we address them further below.

particular type of labor (Equations (2) and (4)), and the choice on the quantity of the type of labor (Equations (3) and (5)) (Burke, 2009; Cragg, 1971; García, 2013). Double-hurdle models were used recently in the agricultural economics literature to estimate labor market effects (Benali et al., 2018; Rao & Qaim, 2013).

The continous outcome variables in Equations (3) and (5) are not normally distributed, which we tested prior to estimation. Therefore, we use an exponentional double-hurdle model, which is suitable for our variable distributions.[5] Alternatively, a tobit model using hyperbolic sine transformations could be employed. Hyperbolic sine transformations are suitable transformations if the variable includes meaningful zeros (Bellemare & Wichman, 2020). We test the double-hurdle specification against the more specific tobit alternative using a likelihood ratio test. The results reject the hypothesis that the tobit is a suitable specificastion in all cases, meaning that the double-hurdle model is preferred (Table A2 in the online Appendix).

3.3 | Definition of key variables

The dependent variables in the different regression models are total labor use per acre of oil palm, as well as labor use by different categeries of laborers, including household and hired labor, male and female labor, and child and youth labor. All these variables are measured in labor days worked per acre of oil palm during the 12 months prior to the survey. Laborers are considered adult if they are 18 years or older. Youth labor includes persons between 15 and 17 years of age, and child labor refers to individuals that are 14 years or younger. Child and youth participation is only counted as labor when the individuals were actively involved in any of the agricultural operations. Activities such as delivering food or water to other laborers or simply accompanying family members without own active involvement are not counted as labor.

Collecting data on child labor can be difficult as employing child labor is forbidden and farmers may be hesitant to provide this information. However, the ban on child labor applies primarily to hired child labor, which is uncommon in oil palm farming in the study area. The use of hired youth labor is also rare in oil palm production. Therefore, child and youth labor in our context refers to children and youths belonging to the farm family, for which farmers openly provided details during the interviews. Nevertheless, we cannot completely rule out a certain reporting bias, which should be kept in mind when interpreting the results.

The key explanatory variables are the two dummies for particiation in marketing and resource-providing contracts, which were already explained above. In addition, we include a set of control variables. At the plot level, we control for soil quality, irrigation, the number of palms per acre, the age of the palms, and the distance from the plot to the closest road that is accessible with a truck, measured in walking minutes. At the household level, we control for the number of adult household members, which is a proxy for the availability of household labor, and the total land size. As the current land size can be influenced by contracts, we use land availability in 2008, which is before most of the farmers had any oil palm contracts.[6] Total land size includes all plots available to the household for cultivation, regardless of whether or not the plots were actually cultivated in 2008. Furthermore, we control for socioeconomic characteristics of the oil palm farmer (age, sex, education, and farming experience). In the household-level models, we control for the characteristics of the household head, who is not necessarily the same person as the oil palm farmer. Finally, we control for distance to the closest market measured in km as a village-level variable.

3.4 | Dealing with potential endogeneity

We use the regression models explained above to evaluate the impact of marketing contracts and resource-providing contracts on labor use. However, farmers self-select into contract participation, so that the exposure variables may be endogenous. Some of the variables that influence contract participation are observed and controlled for. But there may also be unobserved factors that are jointly correlated with contract participation and labor use decisions. Such type of endogeneity could lead to correlation of the contract dummy variables with the error terms and thus bias the estimation results.

Our sampling framework helps to reduce issues of farmer self-selection, because farmers with and without contracts were chosen in different regions, namely, regions that are very similar in terms of regional characteristics but differ in terms of contract availability (see above). However, unobserved heterogeneity may still exist. To control

[5] The exponential double-hurdle model uses the exponential value of the independent variables on the right-hand side instead of taking the logarithm of the dependent variable on the left-hand side of the equation. The left-hand side cannot be log-transformed, due to meaningful zeros in the data.

[6] Some of the farmers with marketing contracts were already contracted before 2008, but the marketing contracts did not affect farm investments and the scale of production, as another recent study with the same data showed (Ruml & Qaim, 2020). The resource-providing contracts, however, affect investments and the scale of production, and these were not available before 2008.

for possible unobserved heterogeneity, we include an individual WTP measure as an additional covariate in the regression models. Details of this approach are explained in the following.

The WTP measure captures the farmer's subjective preference for producing under contract, which is likely correlated with a number of farmer and locational characteristics, including unobserved ones such as risk aversion, time preferences, entrepreneurial skills, and individual market access. Hence, controlling for WTP in the models will reduce possible issues caused by unobserved heterogeneity. Using WTP measures to address endogeneity is an approach that was also recently used in other studies evaluating the impacts of contracts and related marketing institutions (Bellemare & Novak, 2017; Meemken & Qaim, 2018; Verhofstadt & Maertens, 2014).

We derived the farmer's WTP for contracts through a simple experiment that was implemented as part of the survey. In particular, we offered each farmer a set of hypothetical contract offers requiring varying amounts of initial investments. Respondents were asked: "Would you be willing to enter a contract agreement with a company for the establishment of one acre of oil palm that would increase your income but would necessitate an initial investment of Z Ghanaian Cedis (GHS)?" For each respondent, Z started at a low value and gradually increased in follow-up questions.[7] The highest value of Z for which the answer was "yes" represents the individual WTP, which we include as an additional control variable in our regressions. It should be noted that the WTP variable itself is also endogenous and was derived at a time when many farmers in our sample already had a contract. However, we do not use this variable to estimate the effect of WTP on labor use but only to control for unobserved heterogeneity when estimating the effects of contracting.

4 | RESULTS

4.1 | Descriptive statistics

Table 2 shows descriptive statistics and mean difference tests for all outcome variables used. The upper part of Table 2 shows labor use at the plot level. As expected, farmers with a contract use significantly less agricultural labor in oil palm production than farmers without a contract. This is true for both types of contracts, but the difference is especially large for the resource-providing contract. Farmers with a marketing contract use less than half, and farmers with a resource-providing contract only use about one-third of the labor that farmers without a contract use per acre of oil palm. Differences are primarily observed for household labor, including male and female, as well as child and youth labor. For hired labor, differences between plots with and without contracts are not statistically significant. This provides a first indication that both contracts are associated with lower agricultural labor use at the plot level, especially lower household labor use.

The lower part of Table 2 shows the number of days worked in off-farm employment at the household level. For the total number of days worked in off-farm activities, no significant differences between households with and without contract are observed. However, gender disaggregation reveals that households with a marketing contract have more female off-farm labor days than households without any contract. The differences in Table 2 cannot be interpreted as effects of contracts, as the plots and households also differ in terms of several other characteristics (Table A3 in the online Appendix). The regression results presented below control for differences in plot and household characteristics and possible other confounding factors.

Table 3 provides additional descriptive statistics on the type of labor used in each production step. Male adults are more involved than other household members in plot maintenance and harvesting, while female adults are more involved in fruit picking and processing. The overall contribution of child and youth labor is relatively small and mostly concentrated on fruit picking and to a lesser extent harvesting and processing. As discussed above, fruit picking and processing are operations that are no longer carried out on-fam in the modern supply chains with company contracts. In terms of hired labor, male laborers are involved in all operations, except for fruit picking where their contribution is small. Female-hired laborers are mostly involved in fruit picking and harvesting. Noteworthy in Table 3 are also the large standard deviations, indicating that a large variation in the use of household and hired labor exists across oil palm farms.

4.2 | Effects of contracts on agricultural labor use

Table 4 shows the estimated effects of contract farming on total agricultural labor use. The results clearly suggest that contract farming reduces total labor use under both types of contracts. The marketing contract leads to a reduction of 43 labor days per acre of oil palm, which is equivalent to a 55% decrease when compared to the mean labor use of 78 days on oil palm plots without any contract. The resource-providing contract leads to a reduction of 48

[7] We included eight initial investment amounts, ranging from 500 GHS to 4000 GHS, in steps of 500 GHS. The average initial investment amount required for the resource-providing contract is between 3000 and 4000 GHS. However, this amount can vary substantially, depending on the type and quantity of support the individual farmer requests on credit.

TABLE 2 Descriptive statistics for the outcome variables

	Mean			Difference		
	Marketing contract (MC)	Resource-providing contract (RPC)	No contract (NC)	MC-RPC	MC-NC	RPC-NC
Plot-level variables (n = 524)	*(n = 222)*	*(n = 186)*	*(n = 119)*			
Agricultural labor use (in labor days per acre of oil palm)	34.78	26.86	78.06	***	***	***
	(2.16)	(1.87)	(7.24)			
Household labor (in labor days per acre of oil palm)	16.06	11.03	50.91	**	***	***
	(1.60)	(1.16)	(5.17)			
Male household labor	9.71	7.60	27.63		***	***
	(1.13)	(0.88)	(3.19)			
Female household	6.35	3.43	23.28	***	***	***
	(0.81)	(0.53)	(2.93)			
Child labor	0.23	0.11	4.08		***	***
	(0.13)	(0.04)	(1.39)			
Youth labor days per acre	0.50	0.29	3.28		***	***
	(0.26)	(0.09)	(0.96)			
Hired labor (in labor days per acre of oil palm)	17.36	14.97	18.65			
	(1.73)	(1.82)	(3.68)			
Male hired labor	10.67	11.43	12.16			
	(1.14)	(1.22)	(2.41)			
Female hired labor	6.69	3.54	6.49	**		
	(0.87)	(1.02)	(1.77)			
Household-level variables (n = 463)	*(n = 193)*	*(n = 164)*	*(n = 106)*			
Days worked in off-farm employment (per household)	151.32	125.24	117.51			
	(12.63)	(13.50)	(15.84)			
Male days worked in off-farm employment	69.91	62.91	67.71			
	(9.39)	(10.48)	(11.65)			
Female days worked in off-farm employment	81.42	62.33	49.80		**	
	(9.41)	(9.61)	(10.20)			

Notes: Mean values are shown with standard errors in parentheses.

*$p < .1$.

**$p < .05$.

***$p < .01$.

TABLE 3 Labor days in oil palm production by type of labor and production step (mean values per acre)

	Household labor				Hired labor	
	Male labor days	Female labor days	Child labor days	Youth labor days	Male labor days	Female labor days
Plot maintenance	8.59	2.17	0.11	0.33	7.89	0.00
	(10.13)	(5.33)	(1.01)	(1.83)	(12.44)	(0.00)
Input application	0.20	0.91	0.01	0.04	1.78	0.07
	(0.11)	(2.31)	(0.12)	(0.30)	(2.00)	(0.44)
Harvesting and marketing	10.00	7.76	0.54	0.56	8.24	7.49
	(13.78)	(12.85)	(4.57)	(2.64)	(12.25)	(16.26)
Picking of fruits	6.74	8.41	2.34	1.61	0.05	13.10
	(10.57)	(10.52)	(7.00)	(5.07)	(0.24)	(29.25)
Processing	6.01	6.82	0.20	0.88	6.88	2.79
	(13.93)	(11.87)	(2.14)	(3.49)	(11.30)	(6.66)

Note: Mean values are shown with standard deviations in parentheses. Observations were only included if the respective production step was performed on-farm by household or hired laborers (e.g., picking fruits and processing is not performed on-farm for contracted plots).

TABLE 4 Effects of contracts on total labor use in oil palm production

	Labor days per acre
Marketing contract	−43.36***
	(7.89)
Resource-providing contract	−47.94***
	(6.17)
Control variables included	Yes
WTP included	Yes
Observations	524

Notes: Average effects are shown with village cluster-corrected standard errors in parentheses. Full regression results are shown in Table A4 in the online Appendix.
*$p < .1$.
**$p < .05$.
***$p < .01$.

labor days, equivalent to a 62% decrease. The difference in the effects between both types of contracts is not statistically significant.

4.3 | Effects of contracts on labor reallocation and employment

Table 5 shows the effects of contracts on labor reallocation and employment. These estimates are based on double-hurdle models. The results in column (1) suggest that contracts reduce the likelihood of using household labor in oil palm production by 33 and 38 percentage points for marketing and resource-providing contracts, respectively. The results in column (2) further suggest that—for those who use household labor in oil palm production—the number of household labor days per acre is reduced by 25.2 and 30.7 for marketing and resource-providing contracts, respectively.

The effects of both contracts on the likelihood of employing hired labor and the number of hired labor days per acre are small in magnitude and not statistically significant (columns (3) and (4) of Table 5). Table 6 shows unconditional marginal effects combining the results from both hurdles. It becomes obvious that both types of contracts significantly reduce the use of household labor, but not hired labor.

What do households do with the household labor time saved per acre of oil palm? The results in Table 5 suggest that some of the labor saved is reallocated to off-farm economic activities, including wage employment and self-employment.[8] While contracting has no effect

[8] Off-farm wage employment includes teaching, mining, construction, security services, and work in offices, churches, and companies, among others. Oil palm farmers rarely work as laborers on other farms. Off-farm self-employment mostly involves small shops and businesses in trading and processing.

AGRICULTURAL ECONOMICS
The Journal of the International Association of Agricultural Economists

on the likelihood of working off-farm, it significantly increases the number of household labor days in off-farm employment.[9] This implies that households already pursuing off-farm activities increase the time spent in these activities.

As expected, the effect on off-farm employment is bigger for the marketing contract than for the resource-providing contract, in spite of both contracts entailing similar savings in household labor time per acre of oil palm. This can be explained by differences in household livelihood strategies. As mentioned, farmers with a simple marketing contract have limited access to capital for expanding their farming business, so they reallocate the labor saved per acre of oil palm primarily to off-farm activities. In contrast, households with a resource-providing contract have access to credit through their contract, which they use to expand their oil palm area and specialize more on commercial farming, as shown by Ruml and Qaim (2020). Hence, for farmers with a resource-providing contract, much of the labor saved per acre is reallocated on the farm rather than to off-farm activities. This is also supported by the findings in Table 6, which show no statistically significant unconditional effect of the resource-providing contract on the days worked in off-farm employment.

TABLE 5 Effects of contracts on labor reallocation and employment

	Household labor		Hired labor days		Off-farm employment	
	(1)	(2)	(3)	(4)	(5)	(6)
	Decision	Quantity	Decision	Quantity	Decision	Quantity
	0-1	Days per acre	0–1	Days per acre	0–1	Days per household
Marketing contract	−0.33***	−25.17***	−0.04	3.70	0.06	81.96***
	(0.07)	(5.40)	(0.05)	(3.02)	(0.04)	(22.93)
Resource-providing contract	−0.38***	−30.73***	0.02	−3.89	−0.01	54.12**
	(0.06)	(5.92)	(0.05)	(2.86)	(0.04)	(24.55)
Control variables included	Yes	Yes	Yes	Yes	Yes	Yes
WTP included	Yes	Yes	Yes	Yes	Yes	Yes
Observations	524	381	524	422	463	249

Notes: Marginal effects from double-hurdle models are shown with village cluster-corrected standard errors in parentheses. Marginal effects of the second hurdle (quantity) are conditional on the first hurdle being passed. Full results are shown in Tables A5 and A6 in the online Appendix.

*$p < .1$.

**$p < .05$.

***$p < .01$.

4.4 | Gender and age disaggregation for household labor

Table 7 presents disaggregated results for male and female household labor and for child and youth labor. These results are also based on double-hurdle models, as explained above. Both types of contracts significantly reduce male and female household labor use per acre of oil palm. The effects of both contracts on male and female labor are similar in magnitude (the differences are not statistically significant).

The first-hurdle results in columns (5) and (7) of Table 7 further suggest that the likelihood of using child and youth labor is reduced significantly by both types of contracts. The second-hurdle estimates (columns (6) and (8)) also have negative signs and are quite large in absolute terms, especially for child labor. These second-hurdle estimates are not statistically significant, which is probably due to the small number of households using child and youth labor, leading to a small number of observations and large standard errors. Nevertheless, the unconditional marginal

[9] Note that the effects of contracts on the number of labor days in off-farm employment cannot be compared directly to the effect on the number of days worked in oil palm, because the former is measured per household while the latter is measured per acre of oil palm.

TABLE 6 Effects of contracts on labor reallocation and employment (unconditional marginal effects)

	Household labor(days per acre)	Hired labor(days per acre)	Off-farm employment (days per household)
Marketing contract	−28.27***	2.63	61.10***
	(4.77)	(2.82)	(22.84)
Resource-providing contract	−33.36***	−2.67	25.37
	(5.17)	(2.59)	(19.12)
Control variables included	Yes	Yes	Yes
WTP included	Yes	Yes	Yes
Observations	524	524	463

Notes: Unconditional marginal effects are shown with village cluster-corrected standard errors in parentheses. Full results are shown in Table A7 in the online Appendix.
*$p < .1$.
**$p < .05$.
***$p < .01$.

TABLE 7 Effects of contracts on household labor use in oil palm production, by gender and age

	Male labor		Female labor		Child labor		Youth labor	
	(1) Decision 0–1	(2) Quantity Days per acre	(3) Decision 0–1	(4) Quantity Days per acre	(5) Decision 0–1	(6) Quantity Days per acre	(7) Decision 0–1	(8) Quantity Days per acre
Marketing contract	−0.30***	−12.34***	−0.33***	−11.72***	−0.15***	−32.33	−0.17***	−2.97
	(0.05)	(3.21)	(0.06)	(2.32)	(0.02)	(30.23)	(0.04)	(8.23)
Resource-providing contract	−0.32***	−13.77***	−0.41***	−16.94***	−0.12***	−71.05	−0.10***	−13.21
	(0.04)	(3.68)	(0.06)	(2.83)	(0.02)	(95.56)	(0.04)	(29.06)
Control variables included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WTP included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	524	343	524	270	524	46	524	58

Notes: Marginal effects from double-hurdle models are shown with village cluster-corrected standard errors in parentheses. The marginal effects of the second hurdle (quantity) are conditional on the first hurdle being passed. Full results are shown in Tables A8 and A9 in the online Appendix. Unconditional marginal effects are shown in Table A10.
*$p < .1$.
**$p < .05$.
***$p < .01$.

effects show a significant reduction in child labor of 3.3 and 4 days per acre for the marketing and resource-providing contract, respectively (Table A10). This is plausible, given that children in traditional supply chains are particularly involved in fruit picking, an operation that is no longer carried out on-farm in modern supply chains with company contracts.

Table 8 shows gender-disaggregated effects of the contracts on participation in off-farm employment. For male household members, the likelihood of off-farm employment is not significantly affected, but both contracts increase the number of off-farm labor days of male household members considerably (by 105 days and 83 days for the marketing and resource-providing contract, respectively). This suggests that male members in households with and without a contract do not differ in their likelihood to pursue off-farm activities, but males in households with a contract spend significantly more time in their off-farm job. Hence, contracting seems to lead to a reallocation of male labor days to already existing off-farm activities.[10]

[10] It is also possible that male household members change to a different type of off-farm activity through contracting, for instance from casual employment to a more permanent job, in which they work more days per year. Our data do not allow us to analyze different types of off-farm activities in more detail.

AGRICULTURAL ECONOMICS
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TABLE 8 Effects of contracts on off-farm employment, by gender

	Male labor		Female labor	
	(1)	(2)	(3)	(4)
	Decision	Quantity	Decision	Quantity
	0–1	Days per household	0–1	Days per household
Marketing contract	−0.06	104.68***	0.11**	76.95**
	(0.05)	(33.89)	(0.05)	(37.21)
Resource-providing contract	−0.05	82.85**	−0.02	62.98
	(0.04)	(37.14)	(0.05)	(41.26)
Control variables included	Yes	Yes	Yes	Yes
WTP included	Yes	Yes	Yes	No
Observations	463	151	463	130

Notes: Marginal effects from double-hurdle models are shown with village cluster-corrected standard errors in parentheses. The marginal effects of the second hurdle (quantity) are conditional on the first hurdle being passed. Full results are shown in Tables A11 and A12 in the online Appendix. Unconditional marginal effects are shown in Table A13.

*$p < .1$.
**$p < .05$.
***$p < .01$.

TABLE 9 Effects of contracts on hired labor use by gender

	Male labor		Female labor	
	(1)	(2)	(3)	(4)
	Decision	Quantity	Decision	Quantity
	0–1	Days per acre	0–1	Days per acre
Marketing contract	−0.02	1.89	0.10	0.88
	(0.05)	(2.67)	(0.09)	(1.80)
Resource-providing contract	0.11**	−1.33	−0.19**	−2.37
	(0.05)	(2.09)	(0.09)	(2.81)
Control variables included	Yes	Yes	Yes	Yes
WTP included	Yes	Yes	Yes	Yes
Observations	524	401	524	214

Notes: Marginal effects from double-hurdle models are shown with village cluster-corrected standard errors in parentheses. The marginal effects of the second hurdle (quantity) are conditional on the first hurdle being passed. Full results are shown in Tables A14 and A15 in the online Appendix. Unconditional marginal effects are shown in Table A16.

*$p < .1$.
**$p < .05$.
***$p < .01$.

For female household members, the marketing contract increases the likelihood of off-farm employment by 11 percentage points, and the number of female labor days worked in off-farm employment by approximately 77 days.[11] We do not find statistical evidence that the resource-providing contract leads to an increase in female off-farm employment.

Overall, these results indicate that the reallocation of household labor from farm to off-farm employment is more pronounced for male than female household members. And the reallocation to off-farm employment is stronger for the marketing contract than for the resource-providing contract, which is in line with the aggregated results above.

4.5 | Gender disaggregation for hired labor

Table 9 provides gender-disaggregated results for hired labor. Here, we see notable differences for the two contract types. The marketing contract has no significant effect on

[11] A shift of female household labor from on-farm to off-farm activities can have interesting implications for gender roles within the household and for family welfare. Analyzing such aspects in more detail is beyond the scope of this study. Another recent study with data from Tanzania showed that female off-farm employment contributes to an increase in female bargaining power and has non-linear effects on child nutrition (Debela, Gehrke, & Qaim, 2020).

the use of hired labor. In contrast, the resource-providing contract increases the likelihood of employing male hired labor by 11 percentage points, and reduces the likelihood of employing female hired labor by 19 percentage points. These results indicate a substitution of male for female-hired labor.

The unconditional marginal effects, which are shown in Table A16 in the online Appendix, further suggest that the resource-providing contract reduces female hired labor use by 3.4 days per acre of oil palm. This means that female agricultural laborers may potentially suffer from deteriorating employment opportunities through resource-providing contracts.

5 | CONCLUSION

While effects of contract farming on labor use and employment were rarely analyzed in the previous research, the few studies that exist suggest that contracting increases labor demand for agricultural production, harvesting, and postharvest handling (Benali et al., 2018; Khan et al., 2019; Meemken & Bellemare, 2020; Narayanan, 2014; Neven et al., 2009; Rao & Qaim, 2013). We have provided new evidence, showing that the opposite may also be true. Using survey data from the palm oil sector in Ghana, we have shown that contracts reduce total agricultural labor use per acre. The reduction is mainly observed for household labor. For hired labor, we did not identify significant overall effects.

Furthermore, we have shown that some of the household labor saved in oil palm production through the contracts is reallocated to off-farm economic activities. This is in contrast to Otsuka et al. (2016) and Bellemare (2018), who argued that contract farming may reduce smallholder opportunities to pursue off-farm employment. In our study, especially the households with a marketing contract increase the number of labor days in off-farm employment considerably. The marketing contract does not involve any credit options, so households with this type of contract are constrained in their access to financial capital, which would be needed to expand their farm business. Hence, households with a marketing contract reallocate the labor saved to off-farm activities.

Clearly, the effects depend on the context. Previous studies mostly looked at contracts for horticultural crops, which are labor-intensive and where the contracts led to additional production and postharvest operations for meeting specific quality requirements. This is different for oil palm contracts in Ghana. The contracts in Ghana are not associated with special quality requirements. Instead, labor-intensive postharvest handling, which is necessary when selling in traditional supply chains, falls away when selling under contract. The contracting companies buy the oil palm fruit bunches as harvested without any on-farm processing.

While the concrete results presented here should not be generalized, the finding that contract farming can reduce agricultural labor use under certain conditions certainly holds more broadly. Due to the rising international demand for palm oil, supply chains are being modernized in many African countries. New types of processing technologies and contract schemes are gaining in importance. Similar market trends are also observed for other crops traditionally grown by African smallholders.

In addition to evaluating the effects of contract farming on total labor use, we have also disaggregated the analysis by gender and age. We have found no differences in the effects of male and female household labor. However, some gendered substitution of operations in oil palm seems to occur in the sense that a reduction in hired female labor is compensated by a slight increase in hired male labor. Disaggregation by age revealed that contracts significantly reduce the likelihood of using child and youth labor in oil palm. This is because children and youths in traditional supply chains are particularly involved in postharvest operations, which are no longer carried out on-farm in modern palm oil supply chains with company contracts.

A few limitations of our study need to be mentioned. First, collecting information on farm and off-farm household and hired labor requires detailed questions and good memories. Farmers have to recall many details over a 12-month period, so that measurement error can occur. Certain details, such as labor inputs by children and youths, may also be underreported deliberately by farmers. We do not expect systematic differences in misreporting or measurement error between farmers with and without contracts, so that the impact directions will hardly be affected. However, the exact numbers should be interpreted with caution. Second, using cross-section observational data for impact evaluation raises concerns of endogeneity. We have tried to reduce potential endogeneity bias by sampling farmers with and without contracts from regions that are as similar as possible in terms of observable characteristics. We also included an individual WTP measure as an additional covariate to control for possible unobserved heterogeneity. Nevertheless, overinterpretation in a strictly causal sense should be avoided, as some remaining endogeneity bias cannot be ruled out completely.

More research on the labor market effects of contract farming under various conditions is needed. Comparing our results with the few related previous studies suggests that the labor use and employment effects can differ remarkably depending on the particular context. Creation

of decent agricultural and nonagricultural employment is key for sustainable rural development and structural transformation, especially in Africa where rural population growth is still substantial.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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